

# PATENT ABSTRACTS OF JAPAN

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## (54) SOLID-STATE IMAGE SENSOR

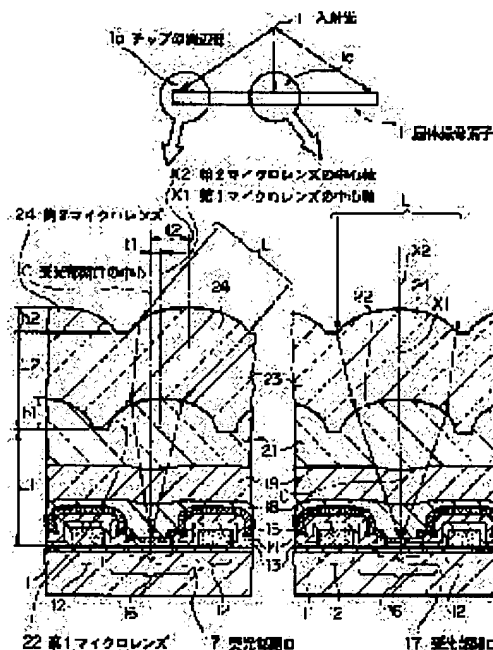
### (57)Abstract:

**PROBLEM TO BE SOLVED:** To suppress shading cause by a reduction of sensitivity in the peripheral region of a picture plane and surface roughness caused by irregularities of pixels in sensitivity even in a camera where an optical system short in eye point distance is used by a method wherein center axes of a first and a second microlens are both set deviating from the center of a light receiving section aperture.

**SOLUTION:** A first micro lens 22 formed by processing a first lens forming film 21 is provided to the upper part of the film 21 over a light receiving section aperture 17.

Furthermore, a second microlens 24 formed by processing a second lens forming film 23 is provided in the upper part of the film 23. The microlenses 22 and 24

and provided making their center axes X1 and X2 deviate from the center C of the aperture 17 with and approach to the chip peripheral part 1a of a solid-state image sensor 1 so as to enable light L incident on the second microlens 24 to impinge of the aperture 17 through the first microlens 22.



## LEGAL STATUS

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the solid state image pickup device which prepared the micro lens above light sensing portion opening in detail about a solid state image pickup device.

[0002]

[Description of the Prior Art] The solid state image pickup device using charge coupled devices (the following, and CCD and CCD are the abbreviation for Charge coupled device) has required the component which can respond also to the short optical system of eye relief with the miniaturization of a camcorder, the application to an endoscope, etc. Since it corresponded to such a demand, the thing of structure as shown in drawing 3 was indicated conventionally.

[0003] That is, as shown in drawing 3, in core 101c of a chip, the lens medial axis X of a micro lens 121 and the core C of the light sensing portion opening 111 are made in agreement, on the other hand, the distance t of the medial axis X of a micro lens 121 and the core C of the light sensing portion opening 111 is shifted at a fixed rate as it goes to periphery 101a of a chip, and each micro lens 121 is arranged.

[0004] It becomes possible by it for the pixel of periphery 101a of a chip to also make the core of the light sensing portion opening 111 carry out incidence of the incident light L. Thus, it is calling shifting and arranging the medial axis X of a micro lens 121 to the core C of the light sensing portion opening 111, saying "Pupil amendment of a micro lens is applied." The distance t of the medial axis X of this micro lens 121 and the core C of the light sensing portion opening 111 becomes large as it goes to periphery 101a from core 101c of a chip, and it serves as max by the pixel of the maximum outline of a chip 101. The value is called the amount of pupil amendments.

[0005] Drawing 4 explains the structure to which pupil amendment of a micro lens is not applied for a comparison. As shown in drawing 4, incidence of the incident light L is carried out to the core of the light sensing portion opening 111 like the time of applying pupil amendment to the pixel of core 101c of a chip. On the other hand, incidence of a part of incident light L is not carried out to the light sensing portion opening 111, but the pixel of periphery 101a of a chip carries out reflecting on the light-shielding film 112 of the edge of the light sensing portion opening 111, or the passivation film 113 etc. When such a phenomenon arises, in periphery 101a of a chip, sensibility nonuniformity, such as lowering of sensibility and shading, occurs especially.

[0006]

[Problem(s) to be Solved by the Invention] However, by the periphery of a chip, if it is going to correspond to optical system with still shorter pupil amendment, since light carries out oblique incidence more, the large amount of pupil amendments must be taken. As such a situation shows to drawing 5, in core 101c of a chip, incidence of the incident light L is carried out to the core of the light sensing portion opening 111. On the other hand, in periphery 101a of a chip, the part is more greatly interrupted very much with a light-shielding film 112, the passivation film 113, etc. with which it was prepared in incident light L around the light sensing portion opening 111 in the distance t of the medial axis X of a micro lens 121, and the core C of the light sensing portion opening 111. Therefore, the problem that

sensibility nonuniformity, such as lowering of sensibility and shading, occurs occurs.

[0007]

[Means for Solving the Problem] This invention is the solid state image pickup device made in order to solve the above-mentioned technical problem. That is, it is the solid state image pickup device which equipped the incidence side of light with the micro lens from light sensing portion opening, and the above-mentioned micro lens consists of the 1st micro lens prepared in the incidence side of light from light sensing portion opening, and the 2nd micro lens prepared in the incidence side of light from the light sensing portion opening and the 1st micro lens of the above. and it is alike, and it follows, and from the core of light sensing portion opening, the medial axis of the 1st micro lens and the medial axis of the 2nd micro lens are boiled, respectively, are shifted, and the 1st micro lens and the 2nd micro lens prepare them so that the light which goes to the periphery of a solid state image pickup device and which carried out incidence to the 2nd micro lens may carry out incidence into light sensing portion opening through the 1st micro lens.

[0008] The micro lens to one light sensing portion opening is further constituted from two sheets of the 1st micro lens prepared in the incidence side of light rather than light sensing portion opening, and the 2nd micro lens prepared in the incidence side of light rather than it by the above-mentioned solid state image pickup device. And each of the 1st and 2nd micro lens So that the light which carried out incidence to the 2nd micro lens may carry out incidence into light sensing portion opening through the 1st micro lens from the thing which go to the periphery of a solid state image pickup device and which it was alike, and it followed, and the medial axis of the 1st micro lens and the medial axis of the 2nd micro lens were boiled, respectively, were shifted, and was established for them from the core of light sensing portion opening Incidence of the oblique-incidence light by which incidence is carried out to a chip periphery is carried out to the core of light sensing portion opening, without carrying out incidence to the surrounding light-shielding film and surrounding passivation film of light sensing portion opening. Therefore, generating of sensibility nonuniformity, such as lowering of sensibility and shading, is controlled.

[0009]

[Embodiment of the Invention] The outline configuration sectional view of drawing 1 explains an example of the operation gestalt of this invention.

[0010] As shown in drawing 1, the insulator layer 13, the light-shielding film 14, and the passivation film 15 grade are formed in the wrap condition in the transfer section 12 prepared in the semi-conductor substrate 11. The light sensing portion opening 17 is formed in the upper (incidence side of incident light L) light-shielding film 14 of the light-receiving field 16 formed in the above-mentioned semi-conductor substrate 11. Furthermore, on the above-mentioned passivation film 15, the 1st lens formation film 21 is formed through the flattening film 18 and a light filter 19, and the 1st micro lens 22 which comes to process this 1st lens formation film 21 is formed in the upper part of the 1st lens formation film 21 above the above-mentioned light sensing portion opening 17 (incidence side of incident light L). Furthermore the 2nd lens formation film 23 is formed in that upper part, and the 2nd micro lens 24 which comes to process this 2nd lens formation film 23 is formed in the upper part of the 2nd lens formation film 23 above the 1st micro lens 22 (incidence side of incident light L).

[0011] and it is alike, and it follows, and the medial axis X1 of the 1st micro lens 22 and the medial axis X2 of the 2nd micro lens 24 are boiled from the core C of the light sensing portion opening 17, respectively, it shifts, and the 1st micro lens 22 and the 2nd micro lens 24 are formed so that the light (henceforth incident light) L which goes to periphery 1a of the chip of a solid state image pickup device 1 and which carries out incidence to the 2nd micro lens 24 may carry out incidence to the light sensing portion opening 17 through the 1st micro lens 22.

[0012] On the other hand, in core 1c of the chip of a solid state image pickup device 1, the medial axis X1 of the 1st micro lens 22 and the medial axis X2 of the 2nd micro lens 24 are formed in the condition of being in agreement with the core C of the light sensing portion opening 17 so that the incident light L to the 2nd micro lens 24 may carry out incidence to the light sensing portion opening 17 through the 1st micro lens 22.

[0013] Thus, it faces forming a micro lens in two-layer, and pupil amendment is applied to each of the 1st micro lens 22 of the 1st layer, and the 2nd micro lens 24 of a two-layer eye. At this time, the amount  $t_1$  of pupil amendments of the 1st micro lens 22, the amount  $t_2$  of pupil amendments of the 2nd micro lens 24 and the height  $h_1$  of the 1st micro lens 22, the height  $h_2$  of the 2nd micro lens 24, and the thickness  $L_1$  and  $L_2$  of each class are suitably set up so that incident light  $L$  may not reflect in the light-shielding film 14 or the passivation film 15 of light sensing portion opening 17 edge. In addition, in core 1c of the chip of a solid state image pickup device 1, it is  $t_1=t_2=0$ , it is set to  $t_1<t_2$  as it goes to periphery 1a of a chip, and  $t_2-t_1$  becomes large.

[0014] Furthermore, in order to make incident light  $L$  refracted by the 1st and 2nd micro lens 22 and 24, it is necessary to periphery 1a of a chip to satisfy the relation expressed to (1) type at least.

[0015]

[Equation 1]

第1マイクロレンズの屈折率 $N_1$  > 第2マイクロレンズの屈折率 $N_2$

..... (1)

[0016] In order to satisfy the above-mentioned (1) formula, the 1st lens formation film 21 is formed by NEGAREJISUTO ( $N_1 \approx 1.6$ ) of transparency, and forms the 2nd lens formation film 23 further by cyclo polymer RAIZUDOFURORINETEDDO polymer system resin [for example, SAITOPPU (trade name)] ( $N_2 \approx 1.3$ ).

[0017] The micro lens to one light sensing portion opening 17 consists of above-mentioned solid state image pickup devices 1 at two sheets of the 1st micro lens 22 and the 2nd micro lens 24. And each of the 1st and 2nd micro lens 22 and 24 So that incidence may be carried out from the 2nd micro lens 24 and incidence may be carried out into the light sensing portion opening 17 through the 1st micro lens 22, even if eye relief is the short incident light  $L$  from the thing which go to the periphery of a solid state image pickup device 1 and which it was alike, and it followed, and the medial axis  $X_1$  of the 1st micro lens 22 and the medial axis  $X_2$  of the 2nd micro lens 24 were boiled, respectively, were shifted, and was established for them from the core C of the light sensing portion opening 17 Incidence of the oblique-incidence light  $L$  by which incidence is carried out to the light sensing portion opening 17 of a chip periphery is carried out to the core of the predetermined light sensing portion opening 17, without carrying out incidence to the surrounding light-shielding film 14 and the surrounding passivation film 15 of the light sensing portion opening 17. Therefore, when sensibility changes a little for every phenomenon (shading) in which the sensibility of the periphery of a solid state image pickup device 1 falls, or pixel, the phenomenon (sensibility nonuniformity) in which a screen is rough is suppressed.

[0018] Next, the manufacture approach of the above-mentioned solid state image pickup device 1 is explained briefly. First, according to the usual process, after forming a light sensing portion, the transfer section, etc. in a semi-conductor substrate, an insulator layer, a light-shielding film, etc. are formed on a semi-conductor substrate. Subsequently, after preparing light sensing portion opening in the light-shielding film on a light sensing portion, the passivation film is formed in a wrap condition for a light-shielding film, light-receiving opening, etc. Then, after forming the flattening film and a light filter, the 1st lens formation film is formed.

[0019] Next, after forming the resist film by spreading on the above-mentioned 1st lens formation film, patterning of this resist film is carried out to the same configuration as the 1st micro lens. This patterning is performed by carrying out reflow processing of that 1st resist pattern, after forming the 1st resist pattern by the above-mentioned resist film with a lithography technique. And etchback of the above-mentioned 1st lens formation film is carried out with the resist film which carried out patterning to the shape of a lens, and the 1st micro lens is formed. In case the 1st resist pattern of the above is formed, the core of light sensing portion opening and the medial axis of the 1st micro lens which it is going to form from now on are made into predetermined distance, and the location of this 1st resist pattern is set up so that incidence may be carried out into light sensing portion opening through the 1st micro lens which incident light tends to form.

[0020] Subsequently, the 2nd lens formation film is formed in a wrap condition for the 1st micro lens of

the above. Subsequently, after forming the resist film by spreading on this 2nd lens formation film, patterning of this resist film is carried out to the same configuration as the 2nd micro lens. Like said patterning, this patterning is performed by carrying out reflow processing of that 2nd resist pattern, after forming the 2nd resist pattern by the resist film with a lithography technique. And etchback of the above-mentioned 2nd lens formation film is carried out with the resist film of the shape of a lens which carried out patterning, and the 2nd micro lens is formed. In case the 2nd resist pattern of the above is formed, the core of light sensing portion opening and the medial axis of the 2nd micro lens which it is going to form from now on are made into predetermined distance, and the location of this 2nd resist pattern is set up so that incidence may be carried out into light sensing portion opening through the 1st micro lens from the 2nd micro lens which incident light tends to form.

[0021] Next, drawing 2 explains an example of another operation gestalt in which the light filter was formed between the 1st micro lens and the 1st micro lens. In drawing 2, the same sign is given to the same component part as said drawing 1 explained.

[0022] As shown in drawing 2, an insulator layer 13, a light-shielding film 14, and the passivation film 15 are formed in a wrap condition in the transfer section 12 formed on the semi-conductor substrate 11, and the 1st lens formation film 21 is formed on this passivation film 15. This 1st lens formation film 21 consists of a plasma silicon nitride film ( $N_1 \times 2.0$ ) or plasma acid silicon nitride (SiON) film ( $N_1 \times 1.7-2.0$ ). The light sensing portion opening 17 is formed in the above-mentioned light-shielding film 14, and the 1st micro lens 22 which comes to process this 1st lens formation film 21 is formed in the upper part of the 1st lens formation film 21 above this light sensing portion opening 17 (incidence side of incident light L). The flattening film 18 is formed in a wrap condition in this 1st micro lens 22, and the light filter 19 is further formed in that top face. The 2nd lens formation film 23 is formed on this light filter 19. This 2nd lens formation film 23 consists of NEGAREJISUTO ( $N_1 \times 1.6$ ) of transparency, or cyclo polymer RAIZUDOFURORINETEDDO polymer system resin [for example, SAITOPPU (trade name)] ( $N_2 \times 1.3$ ). Furthermore, the 2nd micro lens 24 which comes to process this 2nd lens formation film 23 is formed in the upper part of the 2nd lens formation film 23 above the 1st micro lens 22 (incidence side of incident light L).

[0023] And the medial axis X1 of the 1st micro lens 22 and the medial axis X2 of the 2nd micro lens 24 are shifted from the medial axis Xc of the light sensing portion opening 17, and the 1st micro lens 22 and the 2nd micro lens 24 are formed so that the incident light L to the 2nd micro lens 24 may carry out incidence to the light sensing portion opening 17 through the 1st micro lens 22, as it goes to periphery 2a of the chip of a solid state image pickup device 2. For example, the amount t1 of pupil amendments of the 1st micro lens 22 and the amount t2 of pupil amendments of the 2nd micro lens 24 are set up suitably. In addition, in core 2c of the chip of a solid state image pickup device 2, it is  $t_1 = t_2 = 0$ , it is set to  $t_1 < t_2$  as it goes to periphery 2a of a chip, and  $t_2 - t_1$  becomes large.

[0024] On the other hand, in core 2c of the chip of a solid state image pickup device 2, the medial axis X1 of the 1st micro lens 22 and the medial axis X2 of the 2nd micro lens 24 are formed in the condition of being in agreement with the medial axis Xc of the light sensing portion opening 17 so that the incident light L to the 2nd micro lens 24 may carry out incidence to the light sensing portion opening 17 through the 1st micro lens 22.

[0025] Like the solid state image pickup device 1 which also explained the solid state image pickup device 2 explained by above-mentioned drawing 2 by said drawing 1, even if eye relief is the short incident light L, incidence of the oblique-incidence light by which incidence is carried out to the light sensing portion opening 17 of a chip periphery is carried out into the predetermined light sensing portion opening 17, without incidence being carried out to the surrounding light-shielding film 14 and the surrounding passivation film 15 of the light sensing portion opening 17 by the 2nd micro lens 24 and the 1st micro lens 22. Therefore, when sensibility changes a little for every phenomenon (shading) in which the sensibility of the periphery of a solid state image pickup device 2 falls, or pixel, the phenomenon (sensibility nonuniformity) in which a screen is rough is controlled.

[0026] Next, the manufacture approach of the above-mentioned solid state image pickup device 2 is explained briefly. According to the usual process, after forming a light sensing portion, the transfer

section, etc. in a semi-conductor substrate, an insulator layer, a light-shielding film, etc. are formed on a semi-conductor substrate. Subsequently, after preparing light sensing portion opening in the light-shielding film on a light sensing portion, the passivation film is formed in a wrap condition for a light-shielding film, light-receiving opening, etc. Then, the 1st lens formation film is formed.

[0027] Subsequently, after forming the resist film by spreading on the above-mentioned 1st lens formation film, patterning of this resist film is carried out to the same configuration as the 1st micro lens. This patterning is performed by carrying out reflow processing of that 1st resist pattern, after forming the 1st resist pattern by the resist film with a lithography technique. And etchback of the above-mentioned 1st lens formation film is carried out with the resist film of the shape of a lens which carried out patterning, and the 1st micro lens is formed.

[0028] In case the 1st resist pattern of the above is formed, the core of light sensing portion opening and the medial axis of the 1st micro lens which it is going to form from now on are made into predetermined distance, and the location of this 1st resist pattern is set up so that incidence may be carried out into light sensing portion opening through the 1st micro lens which incident light tends to form.

[0029] Furthermore, after forming the flattening film and a light filter in a wrap condition for the 1st micro lens of the above, the 2nd lens formation film is formed. Subsequently, after forming the resist film by spreading on this 2nd lens formation film, patterning of this resist film is carried out to the same configuration as the 2nd micro lens. Like said patterning, this patterning is performed by carrying out reflow processing of that 2nd resist pattern, after forming the 2nd resist pattern by the resist film with a lithography technique. And etchback of the above-mentioned 2nd lens formation film is carried out with the resist film of the shape of a lens which carried out patterning, and the 2nd micro lens is formed.

[0030] In case the 2nd resist pattern of the above is formed, the core of light sensing portion opening and the medial axis of the 2nd micro lens which it is going to form from now on are made into predetermined distance, and the location of this 2nd resist pattern is set up so that incidence may be carried out into light sensing portion opening through the 1st micro lens from the 2nd micro lens which incident light tends to form.

[0031]

[Effect of the Invention] As mentioned above, according to this invention, as explained, so that the 1st and 2nd micro lens may be prepared in the incidence side of the light of light sensing portion opening and the incident light to the 2nd micro lens may carry out incidence to light sensing portion opening through the 1st micro lens since it was alike, and it followed, and the medial axis of the 1st micro lens and the medial axis of the 2nd micro lens were boiled, respectively, were shifted and were prepared from the core of light sensing portion opening, the thing which go to the periphery of a solid state image pickup device and which is done to the core of light sensing portion opening for the incidence of the oblique-incidence light becomes possible. Therefore, even if eye relief is a camera using short optical system, when sensibility changes a little for every shading from which the sensibility of a periphery falls, or pixel, it becomes possible to control the sensibility nonuniformity with which a screen is rough, and improvement in image quality can be aimed at. Since lowering of sensibility is controlled, it becomes unnecessary moreover, to enlarge a light sensing portion and to raise sensibility. Therefore, since optical system can be made small, the miniaturization of a camera can be attained.

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[Translation done.]

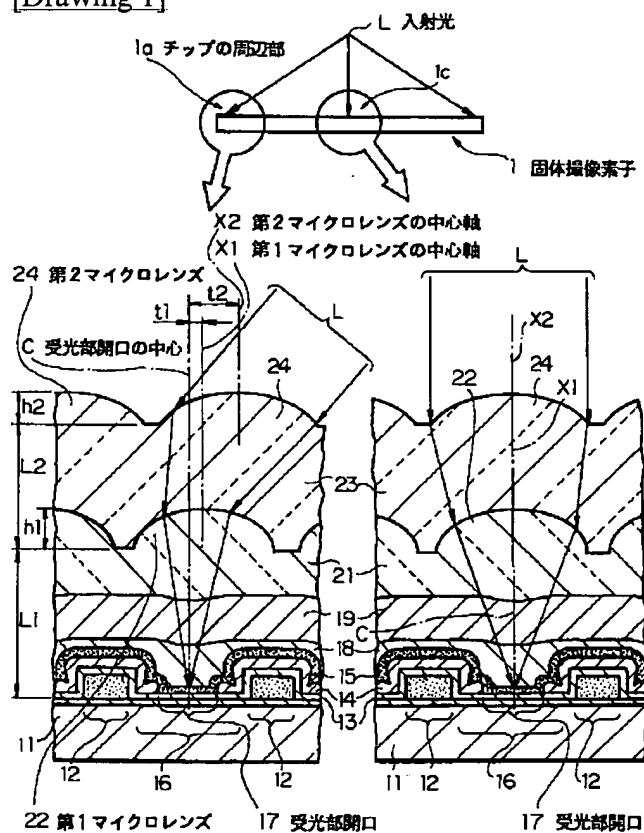
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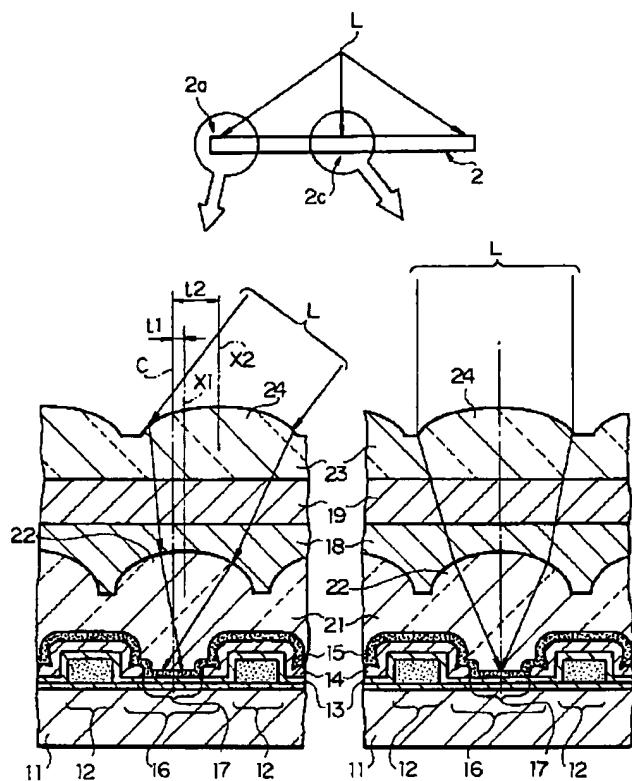
## DRAWINGS

[Drawing 1]



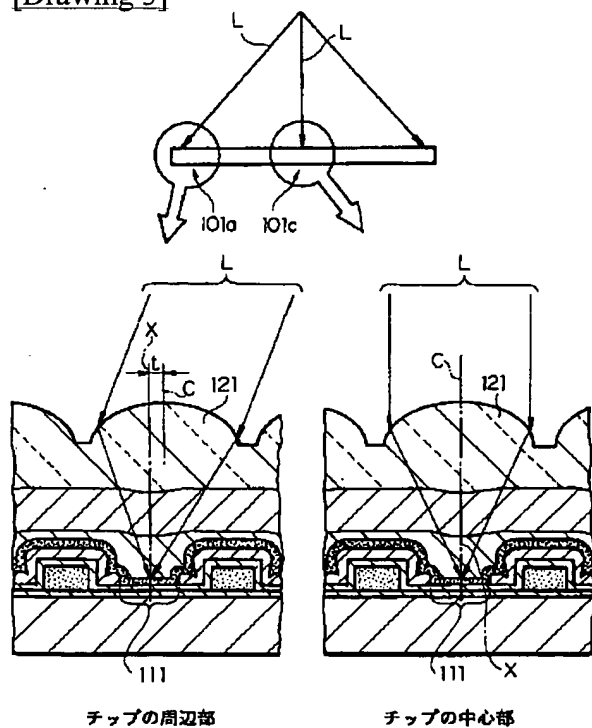
本発明に係わる実施形態の概略構成断面図

[Drawing 2]



別の実施形態の概略構成断面図

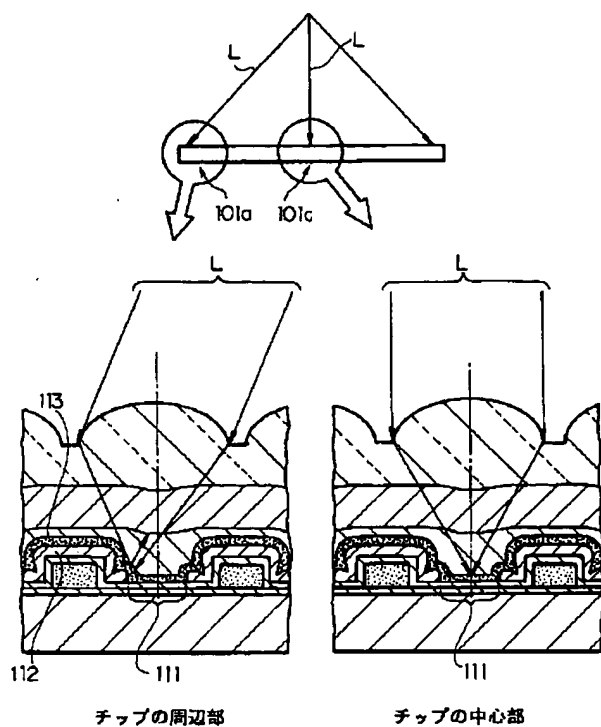
[Drawing 3]



マイクロレンズに隠補正をかけた従来構造の概略構成断面図

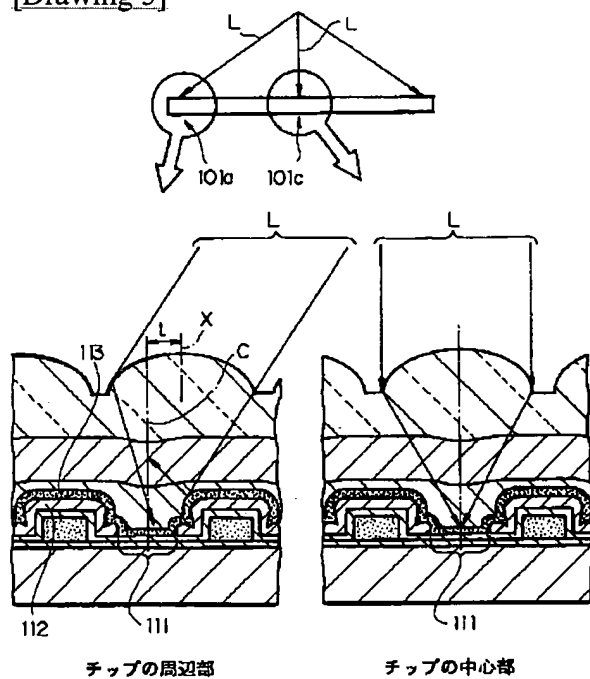
[Drawing 4]





マイクロレンズに瞳補正をかけない構造の概略構成断面図

[Drawing 5]



課題の説明図

[Translation done.]